



## QUOTATION

PROPOSAL NO. 7856/C843.00  
PREPARED FOR: Achiva International Energy Corp.  
PREPARED BY: Benjamin D. Enman

ITEM	QTY	DESCRIPTION
1	LOT	Lubricant Management Services at include: <ul style="list-style-type: none"><li>• Current Lube Program and</li><li>• Establish goals and plan</li><li>• General facility lubrication</li><li>• Develop lubrication plan</li><li>• Oil analysis survey</li><li>• Implement oil analysis</li><li>• Machine condition</li><li>• Implement lubrication</li><li>• practices</li><li>• Implement corrective</li></ul>
2	LOT	Integrated Diagnostic vibration monitoring
3	1	Bentley LUBE™
4	LOT	Supply and
5	6	Machine
6	1	Analysis Base

350 ml

10 25 300

8 250

7 200

6 150

5 100

4 50 ml

3 2 oz

2

1

U.S.A.

approximate

inches

**Kyle Jeffers***Machinery Management Specialist  
Bently Nevada Corporation**e-mail: [kyle.jeffers@bently.com](mailto:kyle.jeffers@bently.com)*

## Bently Lubrication Services – An Overview

**It's 8:30 on a Monday morning.** You had a nice stressful commute to work and now you are staring at all the paperwork, e-mails, voice mails, and to-do lists that are piling up. Welcome to another work week! As you begin thinking about all the things that need to be completed, you suddenly notice pain and tightness in your chest. You think that you might be having a heart attack. Your co-workers have also noticed your discomfort and have called for medical assistance.

The paramedics arrive and put you in an ambulance. They strap all kinds of wires to you to determine your vital conditions. You are transported to a well-equipped and well-staffed hospital; upon arrival, electrodes are attached to your chest and your heartbeat is monitored on an oscilloscope in what the medical profession calls an electrocardiogram (EKG). Simultaneously, a nurse has taken a sample of your blood and has sent it to the in-house lab for analysis.

Initial results of the EKG are inconclusive. The doctors agree that your symptoms are indicative of a heart attack, but could it be something else that's producing them? What are your doctors going to do, rely on your symptoms or the EKG? Meanwhile, the blood analysis comes back from the lab and the hematologists have identified the presence of enzymes in the blood that are produced during a heart attack. With this information, the doctors are confident that you are indeed having a heart attack and begin successfully treating you based on these conclusive diagnostic results.

Your prognosis for a full recovery is excellent. Aren't you glad that you were sent to a hospital that was fully equipped, staffed, and trained to completely and accurately diagnose and treat your symptoms?

Obviously, no machine can equal the value of a human life. However, many machines are extremely expensive and provide a high value for their intended function. Additionally, machines that are not maintained in a healthy manner can cause serious health, safety, and

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oil analysis and  
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environmental risks in addition to lost production. Therefore, maintaining proper machinery health is critical to maintaining a productive and safe environment.

At Bently Nevada, we focus on protecting and monitoring the condition of our customers' machines, and we are recognized worldwide for our capabilities. We have also recognized the existence of other tools to monitor machinery condition that were not within our core competencies. We know that vibration and oil analysis are the two primary methods used to monitor rotating/reciprocating machinery health.

Why our emphasis on oil analysis and lubrication services? The answer to this question lies in the medical example in the beginning of this article – complementary technologies provide stronger diagnostic capabilities. Adding oil analysis and lubrication services to our toolbox adds value to our customers for monitoring machinery health by improving our diagnostic capabilities. We believe it makes just as much sense for Bently Nevada to employ both diagnostic capabilities as it does for the hospital in our example. Coordinating these technologies provides faster, more complete diagnoses and solutions for machinery monitoring.

What have we been doing to make oil analysis and lubrication services a core competency within Bently Nevada? The most significant step we've taken is to recruit experienced

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individuals with backgrounds in oil analysis and lubrication program management from the hydrocarbon processing industry. We are now using this expertise to rapidly train our sales and service personnel to become fluent in the language of lubrication and oil analysis. Second, we have formed a very strong cooperative relationship with National Tribology Services (NTS), an oil analysis lab focusing on root cause diagnostics for industrial machinery. Third, we have developed our own state-of-the-art oil analysis tracking software, Bently LUBE™.

## Our Goal

The objective of our lubrication-related product and service offerings is to maximize machine availability and minimize unit repair costs. While the methods for achieving these objectives can be varied and application specific, the overriding goal is to satisfy what could be called:

## THE FOUR FUNDAMENTAL LAWS OF LUBRICATION

- 1. Select the *CORRECT* lubricant!**
- 2. Keep it *CLEAN*!**
- 3. Keep it *DRY*!**
- 4. Keep it *COOL*!**

One of the most important contributing factors to long machine life is selection of the appropriate lubricant for the application. However, regardless of how good a lubricant may be, it will not perform acceptably if it is allowed to accumulate contaminants and water. From the moment a lubricant is

manufactured to the time it is put into your machine, there are ample opportunities for it to pick up contaminants and water along the way. Minimizing contaminant ingress and improving removal techniques in the storage and handling process can significantly benefit lubricant and machine life. Once a lubricant has been

placed in your machine, it is still under attack from externally and internally generated contaminants. Appropriate prevention, detection, and removal techniques are all necessary to maximize machine and lubricant life. Maintaining the lubricant at the appropriate temperature also contributes to optimum performance. We typically think about this in terms of keeping the lubricant cool to prevent accelerated oxidation rates. However, extremely cold temperatures can cause problems as well, in terms of high viscosity, pumpability, and crystallization.



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The Lubrication Products and Services that Bently Nevada currently offers can be categorized as follows:

- ❖ Lubricant Condition Lab Services
- ❖ Oil Analysis Tracking Software
- ❖ Application Specific Services
- ❖ Oil Analysis Basic Training

## Lubricant Condition Lab Services

Bently Nevada now offers complete oil analysis through our cooperative relationship with National Tribology Services (NTS).

The fit between NTS and Bently Nevada is a good one because both companies focus on machinery condition. Generically, we use the industry-accepted term "oil analysis" to describe this area of our services. More specifically, we are interested in analyzing the oil primarily to determine the condition of the machine. Is the machine healthy and can it continue to operate according to its design? Second, we are concerned about the condition of

the oil itself as it relates to its ability to properly protect the machine. Third, we are concerned about the presence of contaminants and their potentially negative effects on machine and lubricant condition.

## Oil Analysis Tracking Software

The information provided by an oil analysis lab can be greatly enhanced by incorporating the data into a well-designed oil analysis tracking software program. In January 2001, Bently Nevada released Bently LUBE™ software, a powerful oil analysis tracking tool. Bently LUBE™ software allows data to be

imported automatically from virtually any oil analysis lab worldwide. Most of its features are user-configurable and include:

- Equipment hierarchy
- Alarm types
- Alarm setpoints
- Data plots

## Application Specific Services

An expression typically applied to computers is "garbage in/garbage out." That same expression can be applied to oil analysis. The data and subsequent recommendations are only as valid and meaningful as the collected sample quality and the depth



of the information gathered about the machine and its operating environment. The best oil lab and software cannot counteract a poorly collected sample and can only provide recommendations as in-depth as the available machine information.

The number one problem faced by many labs is obtaining detailed information about the machinery they are monitoring. Meanwhile, the most significant problem many oil analysis customers have is knowing what to look for and having the manpower to look for it.

Additionally, many lubrication programs focus only on critical machinery that is already on a routine oil analysis schedule. This means that a majority of the equipment in the facility, as

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much as 90% of the plant balance, is overlooked. One of the many items that Bently Nevada Lubrication Services can provide is a Lubrication Site Assessment where we sit down with the customer to determine and assess the **current situation** of their lubrication program. This could range from no existing program to a well-established program that may only require fine-tuning. Part of this process will be to identify where the customer is experiencing lubrication-related difficulties and determine what the **objectives and goals** of an improved lubrication program should be. The end result would be an overall lubrication program that is specific to each customer's situation, meeting the identified objectives and providing a balance for maximized equipment availability and minimized program and unit repair costs.

A valuable tool for assessing the status of a lubrication program is a **general facility lubrication survey**. This captures information about each machine train, lubricant in use, lubricating system, lubricant change and addition frequency, machine operating environment and duty, and lubricant storage and handling practices.

Information from the lubrication survey and discussions with the customer would then be used to develop or improve an

**overall lubrication program**. Specific areas that would be addressed in a lubrication program include assigning appropriate machine criticality and maintenance philosophy, optimizing lubricant selection, change and sampling frequency, improving contamination control methods, and storage and handling practices.

Machine criticality may be assigned as critical, essential, or balance-of-plant (or similar terminology). Applicable maintenance philosophies may include breakdown, preventive, predictive, or proactive. Optimizing lubricant selection, as well as change and sampling frequencies, results in the proper lubricants being used to maximize machinery and lubricant life. Minimized purchase, storage and handling, and disposal costs are additional benefits to proper lubrication selection.

After the appropriate lubricant has been selected, controlling both solid and liquid contamination represents the next most important factor in optimizing machinery and lubricant life.

Comparison to the human body provides another good example for a machine lubrication system. Our immune system is constantly on the watch for all kinds of externally or internally generated contaminants. One such watch method is the infection-fighting process. When an infection is detected, the immune system kicks into high gear, producing white blood cells by the thousands to fight it. Fortunately, as biological “machines,” our bodies wage this war automatically and for the most part successfully. We typically experience only minor symptoms but, in some cases, they are more severe or persistent. In these situations, we may seek out a doctor who will conduct a variety of tests, including blood analysis, to diagnose the root cause and prescribe medication to aid the body's fight against these attacks.

Machinery, however, has no automatic means of detecting and fighting contamination. It is totally dependent on our efforts to detect, monitor, and take action on signs of contaminant ingress or generation to insure long machinery and lubricant life. As pharmaceutical companies and doctors develop and prescribe drugs and nutritional supplements to improve our health, so do additive and lubricant companies work toward enhancing lubricant and machinery life. Implementing efforts to control contamination can maximize the efforts that have been engineered into the lubricant.

Bently Nevada can also provide assistance in evaluating and **improving lubrication systems** for individual machines or machine trains. These improvements could include implementing contamination control methods to prevent ingress and enhancing removal capabilities. These and other improvements would be application-dependent. The goal is to implement best practices and to minimize the amount of background information (noise) that would interfere with the diagnosis of a real problem.

Another service that Bently Nevada can provide is an **Oil Analysis Survey**, a specialized version of the general facility lubrication survey. Once the general facility lubrication survey has been completed, certain critical and essential machines will be identified as suitable for routine oil analysis. The oil analysis survey is specific to these machines and focuses on issues particularly important to providing the most complete recommendations. Some of the information that would be captured in an oil analysis survey would include detailed information about the machine train components and their metallurgy, lubrication system types and components, contamination control components and their specifications, sample point locations and practices, and sampling frequencies and test packages. The outcome of the oil analysis survey will be the implementation of best practices for oil analysis that maximizes the value of the analysis results and recommendations.

To this point, the services discussed have revolved around gathering detailed, accurate, machine-specific information and implementing best practices. The usefulness of this information is dependent on how well it is applied. To round out Bently Nevada's Lubrication Services, we incorporate **Integrated Diagnostic Services** to provide the customer with Actionable Information® that is machine-specific, detailed, and proactive. These services go beyond typical oil analysis to include the full complement of Bently Nevada's products and services as appropriate.

Available resources that may be utilized include oil analysis and lube survey information, lab analysis results, data analysis through Bently LUBE™ software, and available vibration results and diagnostics. Communication with onsite customer personnel, NTS lab personnel, and Bently Nevada Asset Care and Machinery Diagnostic teams will be very important. Additionally, because Bently Nevada neither manufactures nor

has ties to lubricant or purification system manufacturers, we can work with a customer's preferred supplier in the solutions we provide. In the event that a preferred manufacturer is not already in place, we can work with the various suppliers to provide unbiased, optimum solutions for specific problems.

## Oil Analysis Basic Training

Bently Lubrication Services also provides training in the area of lubrication and oil analysis. This training gives the customer basic insight into the functions of a lubricant and how it is formulated, oil analysis basics, fundamental laws of lubrication, lubrication program management, and keys to implementing a lubrication management program.

This training is intended for customers who seek to gain an understanding about the terminology, testing, and best practices associated with this condition monitoring technology.

## Summary

Bently Nevada's Lubrication Services efforts to optimize machinery and lubricant life can be summarized by satisfying the four fundamental laws of lubrication:

1. Select the **Correct** lubricant!
2. Keep it **Clean**!
3. Keep it **Dry**!
4. Keep it **Cool**!

As any successful company knows, one key to success is continual improvement. In line with that thinking, Bently Nevada recognizes the importance of combining oil analysis expertise with our machine condition monitoring toolbox. We have in place the tools and expertise to provide enhanced capabilities to achieve our mission of helping you protect and manage all your machinery and related production assets.

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